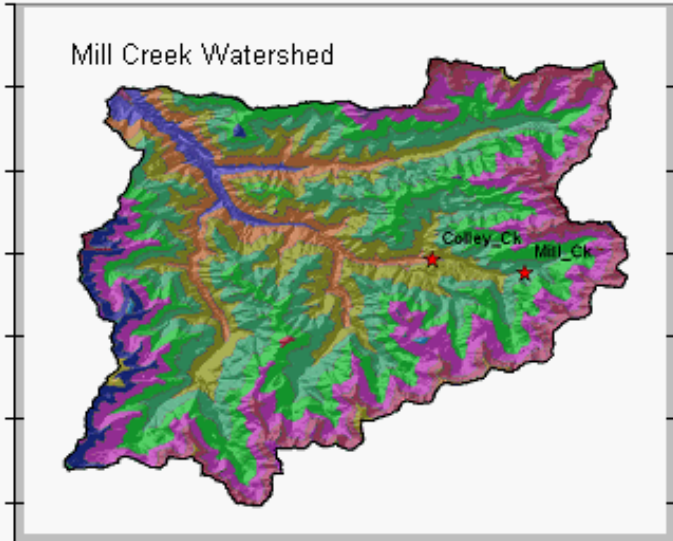
Mill Creek Area/Elevation Curve



Elevation (feet)

11000
10500
10000
9500
9000
8500
8000
7500
7000
6500
6000
5500
5000

0 10 20 30 40 50 60 70 80 90 100

Percent of Total Area

Mill Ck SC 7500'

Colley Ck SC 6300'

minimum elevation - 5175'
maximum elevation - 10700'
total area - 149 sq. mi.
area < 6560' - 14.99 sq. mi. (10.06%)
area btwn 6560'-7875' = 54.24 sq. mi. (36.38%)
area btwn 7875'-9485' = 59.87 sq. mi. (40.16%)
area btwn 9485'-10700' = 19.98 sq. mi. (13.4%)

MILL CREEK SNOW COURSE DATA

Elevation 7500 feet.

Data record 1967 to current

Measured March 1, April 1, and May 1

COLLEY CREEK SNOW COURSE

Elevation 6300 feet.

Data record 1973 to current

Measured March 1, April 1, and May 1

SNOW COURSE DATA FOR ANALYSIS

Currently, Mill Creek and Colley Creek snow courses are used to index the snowpack conditions March 1, April 1, and May 1 for the Upper Yellowstone River Basin.

Should stream gages be installed, the following analysis and products could be made available:

1. **Seasonal volume streamflow forecasts**
2. **Low flow streamflow forecasts**

Note: The earliest any forecasts could be developed would be about 5-10 years after stream gage data becomes available.

SNOTEL ANALYSIS WITHOUT STREAM GAUGING

Rather than snowpack indexing on March 1, April 1, and May 1, SNOTEL data could be indexed on a daily basis.

This would only be for current snow water equivalent, precipitation and air temperature values. There would not be percents of average relationships available for several years until data correlations could be developed.

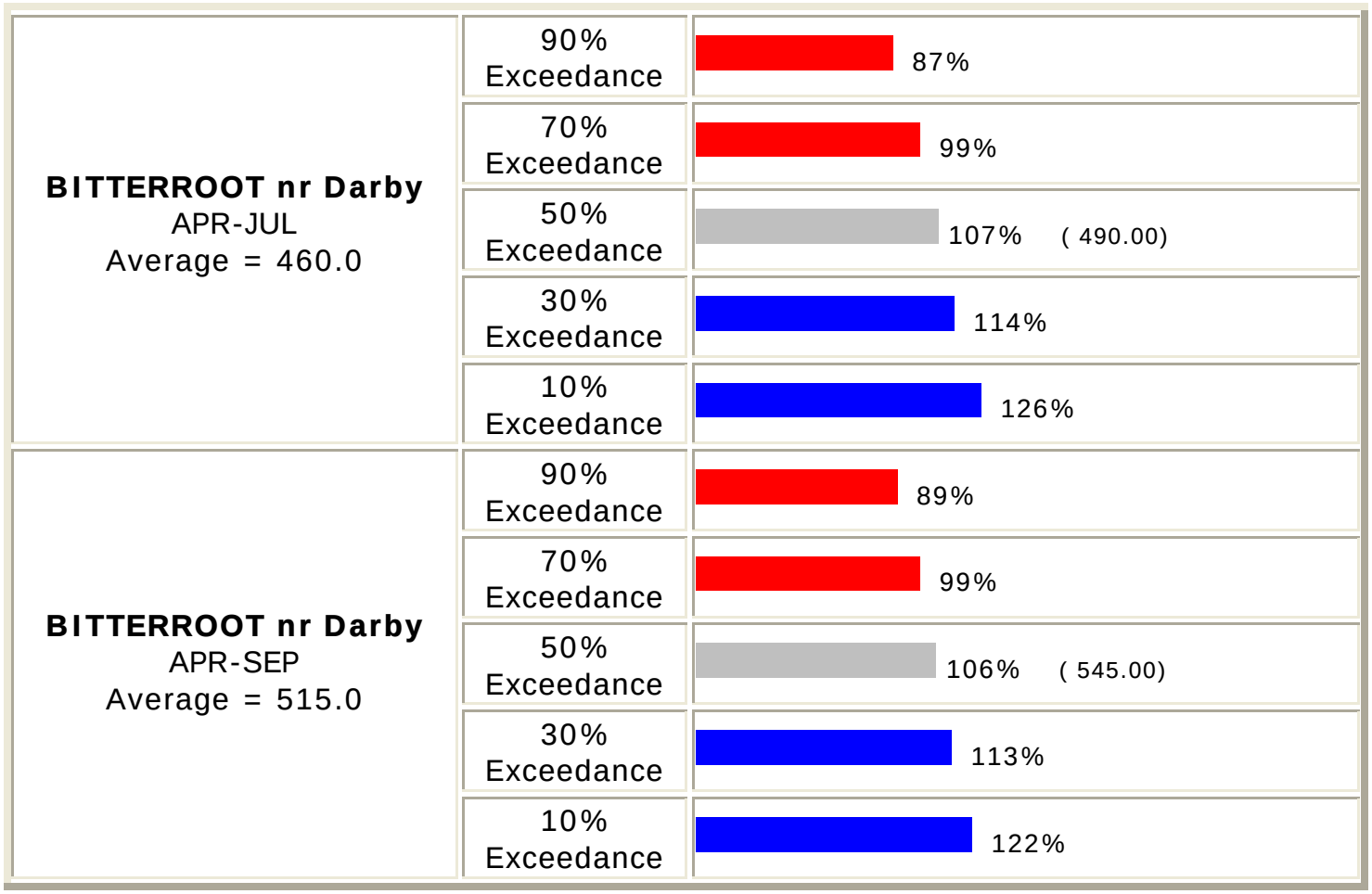
SNOTEL ANALYSIS WITH STREAM GAUGING

- First of month and mid month seasonal volume streamflow forecasts
- Low flow streamflow forecasts
- Snow melt peak date and volume forecasts

Note: The earliest any forecasts could be developed would be about 5-10 years after stream gage data becomes available.

SEASONAL VOLUME FORECASTS

Seasonal volume water supply forecasts are issued January through June, to water managers and water users of Montana.



LOW FLOW FORECASTS

Low flow forecasts are issued for fish biologists, river floaters, irrigators, and local watershed groups so that they can plan in advance and mitigate the potential impacts of critically low streamflows.

Blackfoot River at Bonner updated August 18, 2008.

Assuming average precipitation the Blackfoot River should reach 700 cfs between August 25 and August 29.

Assuming below average precipitation, the Blackfoot River should reach 700 cfs between August 20 and August 25.

Assuming well below average precipitation, the Blackfoot River should reach 700 cfs between August 13 and August 20.

This year the river reached 700 cfs on August 17. Last year (2007) the river reached 700 cfs on July 23.

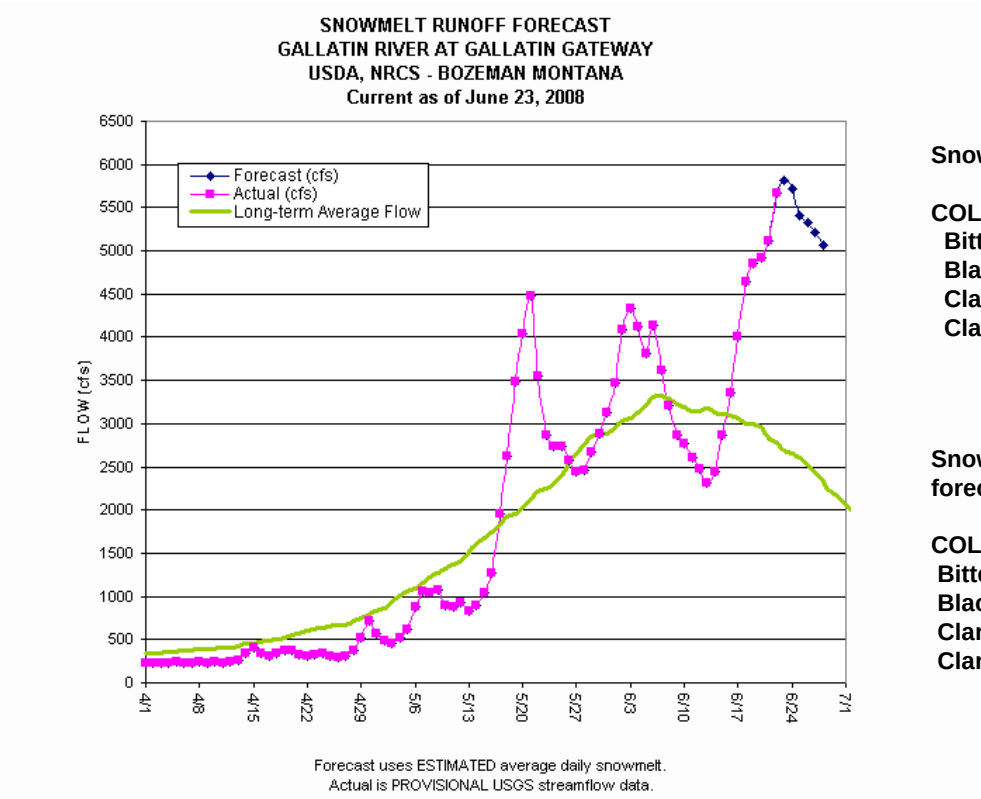
This year the river receded to 2,000 cfs on July 14. Last year the river receded to 2,000 cfs on June 21.

This year the river receded to 1500 cfs on July 19. Last year the river receded to 1500 cfs on June 28.

This year the river receded to 1000 cfs on July 30. Last year the river receded to 1000 cfs on July 8.

SNOWMELT PEAK FORECASTS

Snowmelt peak forecasts are issued annually April through June. These forecast the date and volume of when streams and rivers should crest during the peak snowmelt periods. Snowmelt peak forecasts are used widely by Federal, State, and Local water users and water managers.



Snowmelt Peak Streamflow Forecasts based on May 1 data.

WATERSHED	PEAK FLOW DATES
COLUMBIA RIVER BASIN	
Bitterroot River near Darby	May 26 to June 8
Blackfoot River near Bonner	May 24 to May 31
Clark Fork River above Missoula	May 27 to June 8
Clark Fork River at St. Regis	May 28 to June 5

Snowmelt peak volume forecasts are computed using May 1 streamflow forecasts.

	PEAK RANGE	% OF AVE	AVE
COLUMBIA RIVER			
Bitterroot near Darby	4,900 to 7,600	90 to 139	5,454
Blackfoot near Bonner	7,000 to 10,800	82 to 127	8,512
Clark Fork ab Missoula	13,000 to 19,500	88 to 133	14,698
Clark Fork blw Missoula	25,000 to 37,500	88 to 132	28,482

DETAILED LOOK AT SNOTEL SITE COMPONENTS AND ASSOCIATED COST

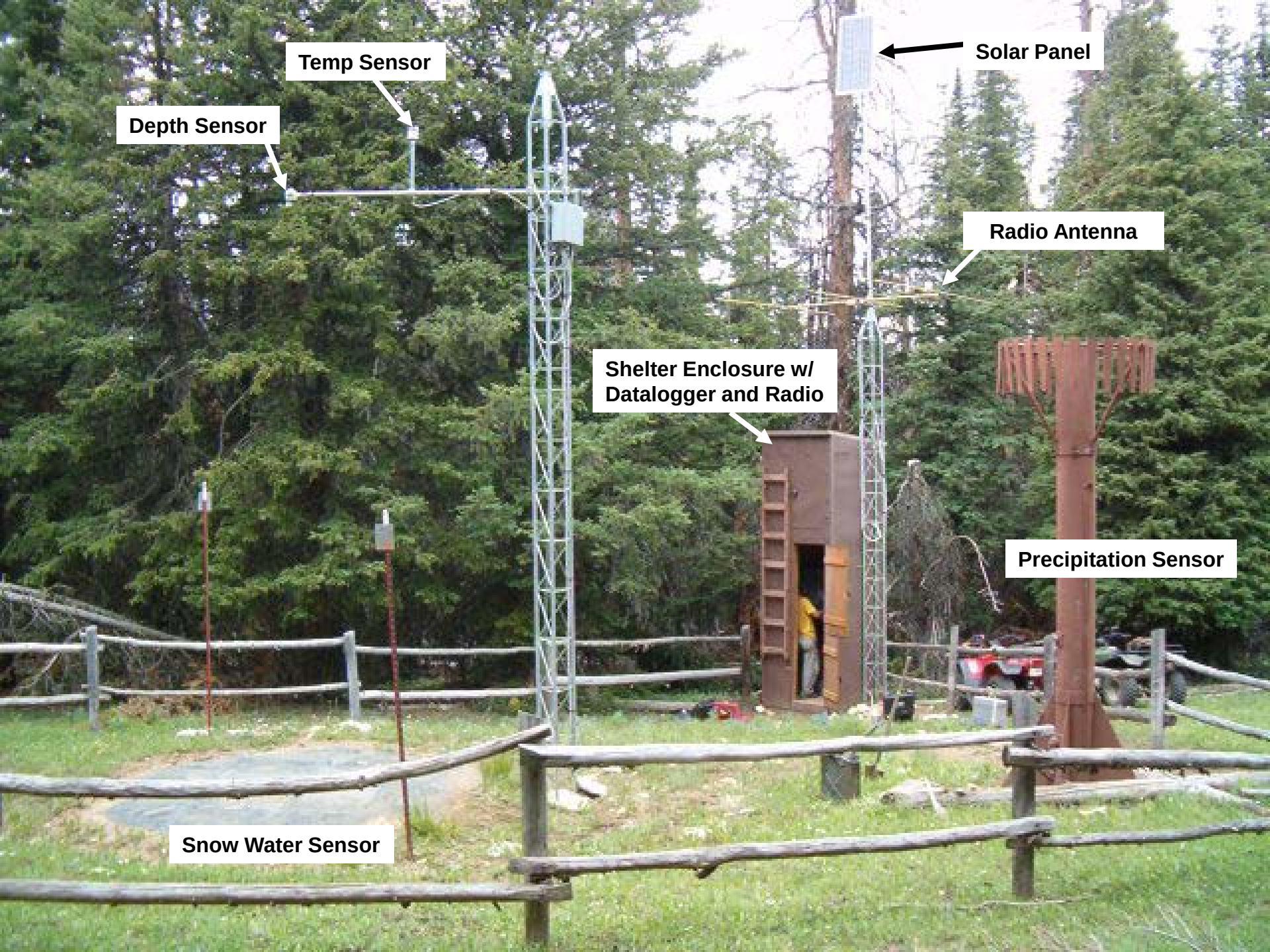
2008 Data Collection Network

CURRENT MONTANA DATA COLLECTION OFFICE SITES

127 SNOTEL Sites (89 in Montana; 36 in Wyoming; 2 in Black Hills of South Dakota) report snow water equivalent, snow depth, precipitation, and temperature data eight times daily.

8 SCAN Sites (Soil Climate Analysis Network) in Montana

166 Snow Courses (137 in Montana; 27 in Wyoming; 2 in Black Hills of South Dakota).


Temp Sensor
Solar Panel
Depth Sensor
Radio Antenna
Shelter Enclosure w/
Datalogger and Radio
Precipitation Sensor
Snow Water Sensor

SNOTEL Site Selection and Installation Process

- **Identify suitable site location on public land that best represents area of interest in watershed**
- **Site can be collocated with an existing snow course, but oftentimes not**
- **Site cannot be installed in Wilderness due to Forest Service regulations**
- **Site should be easily accessible by vehicle (4WD for install, ATV for maintenance)**
- **Final site location should be removed from main traffic area to reduce vandalism**
- **Proposed site will be subject to Forest Service NEPA and cultural resources review**
- **Site will be installed for long term measurements (indefinite)**
- **Site will require approx. 1.0 acre, plus a buffer zone of 400 feet in all directions**

MEASURED PARAMETERS

- **SNOW WATER EQUIVALENT (SWE) – Daily Value and Accumulated Through Water Year Snow Pillow and Manual Measurement (SNOTEL and SNOW COURSE)**
- **SNOW DEPTH – Daily Value with Snow Depth Sensor and Manual Measurement (SNOTEL and SNOW COURSE)**
- **PRECIPITATION – Daily Total and Accumulated Through Water Year (SNOTEL)**
- **AIR TEMPERATURE – Daily Average, Maximum and Minimum (SNOTEL)**
- **SELECT SITES or COOPERATOR REQUESTS**

  Relative Humidity, Soil Moisture Response, Soil Temperature, Wind Speed, Wind Direction, Solar Radiation.

Equipment Costs

Equipment	Estimated Cost
1 – Instrument Shelter Building and mounting base	$2,250.00
1 – Data Collection Platform for remote Communications	$6,750.00
1 – 30’ Rohn tower and associated antenna equipment	$1,150.00
1 – 30’ Rohn meteorological tower for sensor mounting	$450.00
1 – 10’ SNOTEL storage precip gage and mounting platform	$2,250.00
1 – SNOTEL Snow Pillow, fluid and measurement equip	$4,500.00
1 – SNOTEL Judd Snow Depth Sensor	$600.00
1 – Air Temperature Sensor and Shield	$165.00
1 – Relative Humidity Sensor	$590.00
1 – Solar Radiation Sensor	$450.00
1 – Wind Speed/Wind Direction Sensor	$1,050.00
4 – Soil water content and soil temperature sensors	$1,700.00
1 – Miscellaneous supplies and equipment	$1,050.00
TOTAL EQUIPMENT COST ESTIMATE	**$23,150.00**

Equipment Costs

Installation in 2010

Staging / pre-installation preparation – 3 person days	**$600.00**
Site installation and calibration – 10 person days	**$2,000.00**
Travel / Mileage – 6 trucks x 1 trips each x 150 miles (RT) round trip x $0.50 per mile	**$450.00**
TOTAL INSTALLATION COST ESTIMATE	**$3,050.00**

Administration

10% Equipment and Installation Cost	**$2,620.00**
TOTAL COST to Start-up SNOTEL	**$28,820.00**

Operation and Maintenance (O&M)

Year 1 - 10% Install and Purchase Cost	**$2,620.00**
Year 2 – (3% Annual Increase due to Inflation)	**$2,698.00**
Subsequent years Increase 3% Annually	